

canceled. New claims 11-14 have been added. An appendix showing marked-up versions of the amended specification paragraphs and claims is enclosed.

A Letter to the Official Draftsperson is also enclosed with a proposed change to FIG. 3 wherein the word "WARD" has been changed to "WARP".

Claim 1 has been amended to specify that the material is helium impervious. Support for the material being helium impermeable is found in the specification on page 6 at line 18. In addition, claim 1 has been amended to remove the word "modified" and the phrase "melt spun", and to remove the requirement that the weave comprises 56 by 56 yarns/inch.

Claim 2 has been amended by changing the word "thermalplastic" to "thermoplastic", and by removing the acronym "TPUR".

Claims 3 and 4 have been editorially amended to correct typographical errors.

Claim 5 has been amended to depend from claim 1 only.

New claim 11 contains the limitation that the weave comprises 56 by 56 yarns/inch as found in original claim 1.

New claims 12 and 13 specify the minimum tear warp of the material. Support for the material having the specified minimum tear warp is found in FIG. 5.

New claim 14 specifies that the material has a permeability of less than 1 liter/m²/day/atm of helium. Support for this limitation is set forth in the specification on page 4 at lines 10-11.

In Section 1 of the Detailed Action portion of the Office Action, the application has been subjected to a restriction requirement. In response to the restriction requirement, the applicant hereby confirms the provisional election to prosecute the claims directed to the invention of Group I (claims 1-5).

In Section 5 of the Detailed Action portion of the Office Action, claim 2 has been objected to because of an informality relating to the word "thermalplastic". This objection has been addressed through the above amendment to claim 2, wherein the word "thermalplastic" has been changed to "thermoplastic".

In Section 7 of the Detailed Action portion of the Office Action, claims 1-5 have been rejected under 35 U.S.C. §112, second paragraph, as being indefinite for

failing to point out and distinctly claim the subject matter which the applicant regards as the invention. This rejection has been traversed through the above amendment to claim 1, wherein the word "modified" has been removed.

In Section 8 of the Detailed Action portion of the Office Action, claims 1-5 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Tanaka et al. (U.S. Patent No. 4,801,491) in view of Coombs (U.S. Patent No. 4,937,136). Tanaka et al. has been cited as teaching the elements of the claims except for the use of polyethylene fibers woven into a modified rip stop weave architecture and that the weave comprises 56 by 56 yarns/inch and 58 by 58 yarns/inch. With regard to claims 1 and 3, it was considered to be obvious to one of ordinary skill in the art at the time the invention was made to have used 56 by 56 yarns/inch and 58 by 58 yarns/inch as an optimum value. Coombs has been cited as disclosing a protective garment in a rip-stop weave structure. It was considered to be obvious to one of ordinary skill in the art at the time the invention was made to have used Coombs rip-stop method of weaving on the woven cloth of Tanaka et al. This rejection is traversed.

It is respectfully submitted that the present invention as defined by claim 1 contains elements that are neither disclosed nor suggested by the cited references. In particular, claim 1 relates to a material for use as a wall of a flexible pressurized container, and has been amended to specify that the material is hydrogen impervious. In addition, claim 1 requires the use of at least two plies of cloth, with the fill of the individual plies at 90 degrees to each other.

Tanaka et al. relates to a water-resistant, high-strength laminate useful as a cloth such as sailcloth for board sailing. Tanaka et al. neither discloses nor suggests the use of at least two plies of cloth, with the fill of the individual plies at 90 degrees to each other. Nor does Tanaka et al. teach that their cloth would be suitable for use as a wall of a flexible pressurized container, or that it would be hydrogen impervious. Coombs relates to a fabric laminate for a protective garment. Coombs neither discloses nor suggests the use of at least two plies of cloth, with the fill of the individual plies at 90 degrees to each other. Nor does Coombs teach that his cloth would be suitable for use as a wall of a flexible pressurized container, or that it would be hydrogen impervious. In

fact, Coombs teaches away from the invention by disclosing a cloth that is specifically designed to form a vapor permeable moisture barrier.

Furthermore, there is nothing in the teachings of Tanaka et al. and Coombs that indicates that any advantage would be gained by combining their teachings. In addition, even if the teachings of Tanaka et al. and Coombs were combined, the combination would not yield the invention defined by claim 1, since neither Tanaka et al. nor Coombs disclose or suggest use of at least two plies of cloth, with the fill of the individual plies at 90 degrees to each other, or that the materials disclosed therein are suitable for use as a wall of a flexible pressurized container, or that the material disclosed therein are impervious to helium.

The dependent claims add further limitations that are neither disclosed nor suggested by the cited references. For example, claim 2 requires that the plies are joined together by a thermoplastic polyurethane elastomer resin; claim 4 requires that the plies are joined together by a polyester terephthalate film bonded to the outer side of said material; claims 12 and 13 specify the minimum tear warp of the material; and claim 14 specifies that the material has a permeability of less than 1 liter/m²/day/atm of helium. It is respectfully submitted that these dependent claim elements are neither disclosed nor suggested by the cited references.

In the event that any outstanding matters remain in connection with this application, the Examiner is invited to telephone the undersigned at (412) 263-4399 to discuss such matters.

Respectfully submitted,

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Marked-up Version of Changes Made to the Specification and Claims

Specification

Second paragraph, page 1:

The structural envelope/gas bags laminate is composed of 2 to 6 plies of a 2 by 2 basket (56 by 56 yarns/inch) weave with thermotropic liquid (melt spun) crystalline polymer fiber. An optical structural envelope/gas bag laminate is composed of 2 to 6 plies of a Modified Rip Stop (58 by 58 yarns/inch) weave with extended chain polyethylene fiber. Both candidate materials are laminated to an amorphous, thermoplastic polyurethane (TPUR) elastomer film between each ply, providing the structural integrity of the composite laminate in addition to providing a gas barrier, weatherability and wear resistance. A biaxial fabric or resin film is not required to achieve the following strengths[:]; Tensile strength 453 to 3500 kg/5cm, Tear strength 400 to 1633 kg and a base cloth weight of 277 to 742 [g/m²] g/m². Conventional airships and aerostats are produced utilizing a biaxial ply to achieve increased tear strength from a composite skin (envelope/gas bag).

Paragraph bridging pages 1 and 2:

In large volume, in excess of 15 to 60 million cubic feet of Helium, the material used for the envelope/gas bag of non-rigid airships must meet a large number of design requirements such as high strength, provide tear resistance, act as a gas barrier, not be subject of degradation by ultra violet radiation due to exposure to sunlight, and must resist wind erosion. Thus such a material winds up being a multi-layer laminate combining materials with diverse properties. The tension stress loads on any portion of the wall of the envelope/gas bag are at 0 degrees to the longitudinal axis of the envelope/gas bag or 90 degrees thereto (circumferential) hereinafter referred to as axial loads. Thus most laminates include woven filamentary material with the filamentary material orientated at 0 to 90 degree angles. Additionally, to absorb shear stress loads, filamentary material is often included with orientations at plus or minus [forth] forty-five degrees to those absorbing the axial tension loads.

Paragraph bridging pages 2 and 3:

Some modern designs use woven polyester fiber as the axial load carrying material, in addition to a polyester terephthalate film, which provides a Helium gas barrier and [to] absorb~~s~~ shear loads. However, in large non-rigid airships with volume in excess of 15 to 60 million cubic feet of Helium, the strength requirements have dictated the use of very high strength materials such as an extended chain polyethylene fiber or a thermotropic liquid (melt spun) crystalline polymer fiber.

Second paragraph, page 3:

U.S. Patent No. 6,074,722, "Flexible Material For An Inflatable Structure" by R. S. Cuccias, filed February 2, 1997 [solved the problem of insuring that] disclosed a material wherein bias shear load carrying plies had a greater strain to failure value than the axial tension load carrying. The invention included a first flexible layer comprising unidirectional filamentary material at 0 to 90 degrees to each other. A second flexible layer was included having unidirectional filamentary material at 0 to 90 degrees to each other and at forty-five degrees in the filamentary material of the first layer. Critical to the invention was the requirement that the strain value at failure for the filamentary material of the second layer be greater than the 0 and 90 degree filamentary material of the first layer. Of course, the first and second layers were bonded together by a resin, and an additional film as a gas impermeable material and an ultra violet radiation resistant material were bonded to the first two layers. However, such materials are difficult to manufacture accurately with plies at both 0 and 90 degrees and at plus or minus 45 degrees.

Second paragraph, page 4:

A flexible wall material for use in an airship with a volume in excess of 15 to 60 million cubic feet of Helium. In detail, the material is a multi-layer cloth assembly including at least two plies of fiber cloth, with the fiber of the individual cloth layers having a denier generally between 180 to 280 with the fill of the individual plies at 90 degrees to each other and a total weight of between 150 to 478 [g/m²] g/m².

[Permeability of] The permeability is less than 1 liter/[m2]m²/day/atm. Preferably, the material has a weight of 150 to 450 [g/m2] g/m² and an architectural weave comprising 56 by 56 yarns/inch. An optional structural envelope/gas bag laminate is composed of 2 to 6 plies of a modified Rip Stop (58 by 58 yarns/inch) weave with extended chain polyethylene fiber and having a total weight of 159 to 478 [g/m2] g/m². VECTRAN fibers made by Celanese Acetate LLC of Charlotte, N.C. and SPECTRA fibers made by Honeywell Performance Fibers of Morristown, N.J. are applicable materials. Both candidate materials are laminated to an amorphous, thermoplastic polyurethane (TPUR) elastomer film between each ply providing the structural integrity of the composite laminate in addition to providing a gas barrier, weatherability and wear resistance.

First paragraph under the heading "Description of the Preferred Embodiment", page 6:

Illustrated in Figure 1 is a perspective view of very large [non-ridged] non-rigid airship with a volume in excess of 15 to 60 million cubic feet of Helium, generally designated by the numeral 10. The vehicle 10 includes an envelope/gas bag 12 having a longitudinal axis 13A, lateral axis 13B and a vertical axis 13C. It should be understood that the vehicle 10 could be constructed from a series of separate envelope/gasbags joined together to form the illustrated shape. A gondola 14 is suspended from the envelope/gas bag 12 and incorporates a plurality of propulsion systems 16 mounted thereon. If the vehicle is very large, enormous stress levels can be introduced into the envelope/gas bag 12.

Second paragraph under the heading "Description of the Preferred Embodiment", page 6:

Additionally, the envelope/gas bag 12 must be impervious to Helium gas; not be [effected] affected by ultra-violet radiation; and capable of being [seemed] seamed together from a large number of panels. Meeting all these requirements requires a laminated multi-layer flexible cloth assembly having specific mechanical properties.

First paragraph, page 7:

In Figure 2, a portion of the envelope/gas bag 20 is illustrated having an inside surface 22 and outside surface 24 and is composed of multiple layers of

filamentary material in a manner to be subsequently discussed. The main stress loads are introduced along the 0 degree axis, aligned with the longitudinal axis 13A, and indicated by numeral 26, and 90 degrees thereto indicated by numeral 28. Thus the main load carrying filamentary material should be aligned with these [axis] axes.

Second paragraph, page 7:

Referring to Figure 3 the envelope/gas bag 20 is made by forming a stack 42 by laying up four layers of woven cloth 42A, 42B, 42C, and 42D, with the threads 43 of each layer woven in a 2x2 basket weave architecture. The denier of the cloth is between 180 and 280 and, preferably between 200 and 215. The threads 43 of the layers 42 are made of a thermotropic liquid (melt spun) crystalline polymer fiber[]. The fill of each layer 42A-D alternates between 0 and 90 degrees to each other layer. Resin sheets 46 are placed on the inside and outside surfaces 22 and 24 of the layers 42 and also between each layer 42A-D. The resin sheets are preferably made from a [thermalplastic] thermoplastic polyurethane (TPUR) elastomer, because the envelope/gas bag 20 is a gasbag for a [non-ridged] non-rigid lighter-than-air ship 10. A fifth layer 48 of a material that is resistant to degradation by ultra violet radiation such as a polyester terephthalate is bonded to the outside surface 24. As illustrated in Figure 3, the material is illustrated in its "lay-up form" for purposes of illustration. When the layers are bonded together, the sheets of resin 46, flow together and impregnate the layers of cloth 42A-D. Thus the layers 42A-D can be said to be encapsulated in a resin matrix and the envelope/gas bag 20 can be characterized as a flexible composite material.

Paragraph bridging pages 7 and 8:

Referring to Figure 4, in a second embodiment, the envelope/gas bag 20 is made from forming a stack 62 by laying up to six layers of woven cloth [62A,62B,62C,62D,62E] 62A, 62B, 62C, 62D, 62E and 62F, with the threads 63 of each layer woven in a modified rip stop weave architecture. Again the denier is between 180 and 280 with the preferred range of 180 to 215. As illustrated, the threads 63 are made of extended chain polyethylene. The fill of each layer 62A-F alternates between 0 and 90 degrees to each other. Resin sheets 66 are placed on the inside and outside surfaces 22

and 24 of the stack 62 and also between each layer 62A-F. The resin sheets 66 are also preferably made from polyurethane elastomer resin. A seventh layer 68 of a material that is resistant to degradation by ultra violet radiation is bonded to the outside surface 24, again a polyester terephthalate film. The envelope/gas bag 20 is again illustrated in its "lay-up form" for purposes of illustration. As in the previous example, when the layers are bonded together, the sheets of resin 66, flow together and impregnate the layers of cloth 62A-F. Thus again, the layers can be said to be encapsulated in a resin matrix and the envelope/gas bag 20 can be characterized as a flexible composite material.

First full paragraph, page 8:

Referring to Figure 5, which is a bar chart comparing the ultimate strength of multi-layer cloth assembly versus the number of plies, the ultimate strengths in warp and fill tear strengths and warp and fill tensile strengths are generally equal. This eliminates the need for plies at plus or minus 45 degrees to absorb shear loads. In addition, [the fact that the even] a six ply material has a thickness of only 0.035 inch, and it is flexible and crease resistant.

Abstract

This invention relates to airships, with a volume [in] of 15 to 60 million cubic feet of Helium. More particularly, it relates to improved structural envelope/gas bags or outer covers for lighter-than-air and neutral buoyancy airships. In detail, the material is a multi-layer cloth assembly including at least two plies of fiber cloth, said cloth comprising 56 by 56 yarns/inch with a total weight of 150 to 450 [g/m²] g/m², with the fiber of the individual cloth layers having a denier generally between 180 and 280 and with the fill of the individual plies at 90 degrees to each other. Preferably, the filaments should be between 200 and 215 denier. The fibers of each layer of cloth are selected from the group consisting of extended chain polyethylene polymer or a thermotropic liquid (melt spun) crystalline polymer. The extended chain polyethylene fiber is a woven

modified rip stop weave architecture, while the thermotropic liquid (melt spun) crystalline polymer fiber is a 2x2 basket weave architecture.

Claims

1. (Amended) A helium impervious material for a wall of a flexible pressurized container comprising at least two plies of cloth, said cloth having a weight of 150 to 450 [g/m²] g/m², said cloth comprising fiber having a denier generally between 180 and 280 and the fill of the individual plies at 90 degrees to each other, said fibers of said cloth selected from the group consisting of extended chain polyethylene polymer in a [modified] rip stop weave architecture and a thermotropic liquid [(melt spun)] crystalline polymer in a 2x2 basket weave architecture[,said weave comprising 56 by 56 yarns/inch].
2. (Amended) The material as set forth in [Claim] claim 1, wherein said plies are joined together by a [thermalplastic] thermoplastic polyurethane [(TPUR)] elastomer resin.
3. (Amended) The material as set forth in claim 1, wherein said cloth has a weight of 159 to 478 [g/m²] g/m² and said weave comprises 58 by 58 yarns/inch.
4. (Amended) The material as set forth in [Claim] claim 2, wherein said plies are joined together by a polyester terephthalate film bonded to the outer side of said material.
5. (Amended) The material as set forth in [Claim 1, or 2, or 3, or 4] claim 1, wherein the denier is between 180 and 215.

New Claims 11-14

11. (New) The material as set forth in claim 1, wherein the weave comprises 56 x 56 yarns/inch.
12. (New) The material as set forth in claim 1, wherein the fibers comprise the thermotropic liquid crystalline polymer in a 2x2 basket weave architecture and wherein the material has an ultimate tensile strength of at least 800 lbs/inch width.
13. (New) The material as set forth in claim 1, wherein the fibers comprise the extended chain polyethylene polymer in a rip stop weave architecture and wherein the material has an ultimate tensile strength of at least 600 lbs/inch width.

14. (New) The material as set forth in claim 1, having a permeability of less than 1 liter/m²/day/atm of helium.

Claims 6-10 have been cancelled.